

CASE REPORT

CUBOID MANIPULATION AND EXERCISE IN THE
MANAGEMENT OF POSTERIOR TIBIALIS
TENDINOPATHY: A CASE REPORTCatherine Patla, PT, DHsc, OCS¹Janice Lwin, PT, DPT, OCS²Laura Smith, PT, PhD, DPT, OCS³Eric Chaconas, PT, DPT, CSCS¹

ABSTRACT

Background and Purpose: Posterior tibialis tendinopathy is a prevalent musculoskeletal condition often resulting in gait abnormalities along with medial ankle and foot pain. The purpose of this case report is to describe the treatment of a patient with a three year history of posterior tibialis tendinopathy utilizing a combination of cuboid manipulation and exercise.

Case Description: The patient was a 23-year old female recreational runner and collegiate basketball player reporting a three year history of chronic left ankle and lower leg pain. Outcome measures included the numeric pain rating scale, lower extremity functional scale, strength, passive joint mobility, and functional activities including running distance. Standard care for the treatment of tendinopathy was followed for six weeks with minimal functional improvements. Clinical reasoning skills were applied to redirect the hypothesis implicating limitations in cuboid-calcaneus internal rotation joint mobility contributing to a posterior tibialis tendinopathy. Manipulation at this joint was utilized to restore mobility. This intervention resulted in an immediate reduction in symptoms and improved functioning. Both muscle strengthening and functional task training were implemented post manipulation.

Outcomes: At discharge, the patient reported full recovery and no pain with running 14 miles. Her lower extremity functional score improved to 78/80, posterior tibialis strength increased to 4/5 and the patient was able to perform 12 single leg heel raises without pain.

Discussion: By restoring cuboid internal rotation mobility, associated midtarsal pronation, and lower extremity neuromuscular control, the posterior tibialis muscle was able to perform efficiently, thus resolving the chronic tendinopathy and returning the patient to optimum functional ability of running.

Key Words: posterior tibialis tendon dysfunction, cuboid, manipulation, clinical reasoning.

Level of Evidence: 4

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BACKGROUND AND PURPOSE

Posterior tibialis tendinopathy is a prevalent musculoskeletal condition that includes a spectrum of tissue changes around the foot and ankle complex.¹ The symptoms can vary and may include pain located on the medial lower leg, ankle, heel and medial foot.^{2,3} Common functional limitations include pain with propulsion off the toes and abnormal gait due to pain.^{3,4} Posterior tibialis tendinopathy is referenced in the literature with similar names including: posterior tibialis tendon dysfunction (PTTD), tibialis posterior tendon (TPT), or tibialis posterior myofascial tightness (TPMT). This manuscript will use the PTTD identifier.^{3,4}

The reported etiology of PTTD varies from acute trauma to gradual onset micro-trauma including idiopathic onset.^{3,4} Johnson & Strom⁵ initially described three distinct stages of posterior tibialis tendinopathy as Stage I with swelling, Stage II with a partial tear and Stage III identified as a complete tear. The three examination findings used to diagnose PTTD stage I include: swelling behind the malleoli, medial foot and ankle pain with single heel raise and palpable tenderness of the posterior tibialis tendon.⁵ Stage II is characterized by increased levels of functional limitation, inability to perform a single heel raise and a mid-foot pronation deformity.⁵ Stage III includes the above signs identified in Stage II and the hindfoot pronation deformity often becomes permanent.⁵ Advanced cases of Stage III PTTD can include lateral compression pain between the calcaneus and distal fibula.⁵ Patla & Abbott³ further expanded this classification system to identify and describe a pre-stage I PTTD. Pre-stage I is devoid of tendon swelling although posterior tibialis muscle tightness, weakness, and functional activity limitations are present.³ It is proposed that Stages II and III may require surgical intervention while Stage I and pre-Stage I can be effectively treated with conservative management.⁵ Treatment varies dependent on the stage of injury healing and patient presentation. Management in Stage I is primarily focused on the elimination of tendon swelling. Since swelling is absent with pre-Stage I PTTD, specific interventions to the posterior tibialis muscle addressing tightness and loss of strength may be the focus of treatment.

In addition to these interventions, manipulation of the mid-tarsal joints and ankle has been described

as an effective treatment for various lower leg conditions.⁶ Improvement in pain and function after joint manipulation to the foot has been described for various conditions including cuboid syndrome,⁷ iliotibial band friction syndrome,⁸ and plantar heel pain.⁹ A paucity of research exists relating joint manipulation to the foot and PTTD. The purpose of this case report is to describe the combination of cuboid-calcaneous joint manipulation and therapeutic exercise for a patient with a three year history of pre-Stage I PTTD.

CASE DESCRIPTION

The patient was a 23-year old female collegiate basketball player and recreational runner who was informed that the data concerning her case would be submitted for publication. She had experienced a gradual onset of sharp pain over the medial lower leg and ankle that had persisted for three years. Aggravating factors included any activity increasing weight-bearing mid-tarsal pronation, especially walking without shoes and running. The patient was unable to ambulate with a normal gait due to pain. She reported the discomfort eventually became so intense that she walked on the outside of her foot to avoid pain. At the time of initial examination, the patient was unable to run any distance due to 9/10 pain on the Numeric Pain Scale Rating (NPRS). The NPRS is a valid and reliable pain assessment tool that can be utilized in a variety of settings for musculoskeletal pain.¹⁰ The location of pain was on the medial lower leg and ankle within the first steps of running. Plain film radiographs were negative for fracture and ankle joint abnormalities. The patient denied a history of any similar injury on either extremity and she reported no other health problems. The patient failed an initial course of rehabilitation with another healthcare provider which included cryotherapy, isotonic strengthening at the ankle and balance training. Despite ongoing symptoms, the patient reported that she had continued to play collegiate basketball for a year beyond the initial onset of pain. Her pain worsened approximately two years after initial onset when she began running long distances. The patient provided her consent for use of her information for publication.

EXAMINATION

The Lower Extremity Functional Scale (LEFS) is an 80-point patient reported functional outcome

Table 1. Examination Outcome Measures				
Outcome Measure		Examination Session 1	Treatment Session 6	Treatment Session 12
Active Range of Motion (Degrees)	Ankle Dorsiflexion	5 degrees	6 degrees	10 degrees
	Ankle Plantar Flexion	58 degrees	58 degrees	60 degrees
	Inversion	45	45	47
	Eversion	11	11	11
Muscle Strength	Posterior Tibialis	Unable to test due to pain	3+/5	4/5
	Anterior Tibialis	4-/5	4-/5	4+/5
	Bilateral Heel Raise	Unable to perform	3 repetitions	15 repetitions
	Single Leg Heel Raise	Unable to perform	Unable to perform	10 repetitions
Functional Self Report	Running Distance	Unable to run	400 meters	13.1 miles
	Lower Extremity Functional Scale	63/80	65/80 (Visit #8)	78/80
Numeric Pain Rating Scale	At Rest	3/10	2/10	0/10
	With Ambulation	5/10	5/10	0/10
	With Running	9/10	7/10	0/10

measure with lower scores indicating greater disability.¹¹ The patient scored a 63/80 upon initial examination. The LEFS has been reported as having high internal consistency and construct validity for individuals with ankle injuries.¹² Lower extremity active range of motion (AROM) and passive range of motion (PROM) were assessed in the supine position according to Norkin and White.¹³ Left ankle AROM and PROM was limited and painful as outlined in Table 1. The modified arch ratio was measured as reported by Hegedus et al.¹⁴ Interrater reliability for the modified arch ratio was reported with an intraclass correlation coefficient of 0.961.¹⁴ The patient was identified as having an increase in arch height upon comparison to the uninvolved foot. During ambulation the patient demonstrated minimal weight-bearing along the 1st ray and great toe at the push off phase of gait. Midtarsal supination was maintained throughout stance phase. When the patient was instructed to run, pain at the medial lower leg, posterior to medial malleoli and navicular immediately increased to 9/10 on the NPRS. Resting pain as measured by the NPRS was reported as 3/10 and 5/10 with ambulation.

Assessment of posterior tibialis muscle strength was performed with the patient supine, resisting plantarflexion and inversion of the ankle as described by Kendall.¹⁵ Functional plantar flexion strength

was attempted in standing following techniques described by Kulig⁴ using single and double leg heel raises. However, attempts to manual muscle test posterior tibialis and functional heel raises were painful and assessment was incomplete. Muscle testing results are reported in Table 1. Length test of the posterior tibialis muscle was attempted as described by Patla³ however testing was incomplete as the patient was unable to be placed in test position due to pain.

CLINICAL IMPRESSION

Given the strength, range of motion and functional impairments found during initial evaluation as well as reports of pain, the patient was diagnosed with pre-Stage I posterior tibialis tendon dysfunction (PTTD). This diagnosis was evidenced by decreased active and passive left ankle dorsiflexion ROM with pain, painful and limited double and single leg heel raising, gastrocnemius and posterior tibialis weakness with pain, tenderness to palpation deep in the medial lower leg in the region of the posterior tibialis muscle belly and specifically at the tendon posterior to the medial malleoli. Moreover, during ambulation pain was provoked at the medial lower leg and ankle in the region of the posterior tibialis muscle and tendon. Swelling of the tendon was not identified. These findings supported the hypothesis of pre-Stage I PTTD.

INTERVENTION

Initial phase Week 1-6 (Six treatment sessions)

The initial phase of treatment consisted of posterior tibialis stretching, soft tissue mobilization, therapeutic exercise and taping. Stretching of the gastrocnemius was performed in the long sitting position with full ankle dorsiflexion and knee extension. Stretching the posterior tibialis was performed passively with the patient in the prone position, knee flexed to 90 degrees with ankle dorsiflexion and eversion. In this position the therapist provided pressure at the posterior tibialis tendon attachments of the navicular and cuneiforms as described by Patla and Abbott³. Soft tissue mobilization included cross friction massage of the posterior tibialis tendon on the medial ankle. Therapeutic exercises included: Contralateral leg kicks with single leg balance to recruit lower leg muscles for proprioceptive training (Figure 1), slow double heel raises while squeezing a ball between heels to bias the posterior tibialis contraction (Figure 2), and double leg heel raises for loading of the ankle plantar flexors.

Elastic taping techniques were utilized for palliative relief of pain at the medial lower leg for treatment sessions two through five. Tape was applied from the medial heel of the foot to the proximal medial lower leg. Although the patient was still unable to run, the initial phase of rehabilitation resulted in a reduction of pain on the NPRS to 2/10 at rest, 5/10 during ambulation and 7/10 during an attempt to run. Functional limitations persisted and she was

still unable to run due to medial lower leg, posterior to medial malleoli and medial navicular pain. Moreover, the patient was still unable to perform midtarsal pronation without pain. She continued to demonstrate muscle weakness in the gastrocnemius and posterior tibialis and was unable to do a single leg heel raise on the involved side due to pain.

A re-examination during the sixth visit determined that midtarsal pronation was limited along with a limitation in cuboid internal rotation mobility. Testing cuboid internal rotation (Figure 3) was con-



Figure 2. Ball squeeze heel raise performed by inverting each ankle to hold ball while concurrently performing the heel raise



Figure 1. Contralateral leg kick exercise performed by standing on the involved leg and kicking the uninvolvement leg in varying directions



Figure 3. Cuboid internal rotation mobility assessment performed by stabilizing the mid-tarsal joints with the left hand while the right hand passively moves the cuboid into internal rotation

ducted as described by Brandon and Patla.⁸ A disruption in cuboid arthrokinematics has been described to be a part of cuboid syndrome and has been associated with foot and ankle pain.¹⁶ The impaired cuboid mobility resulted in an additional diagnosis of cuboid syndrome potentially contributing to pre-Stage I PTTD. Since cuboid internal rotation occurs with mid-tarsal pronation, a limitation in this motion may contribute to the lack of mid-tarsal pronation. As a result, a cuboid manipulation for internal rotation was indicated.

Week 7-17 (Six treatment sessions)

The limitation of cuboid internal rotation was addressed with one treatment utilizing a cuboid whip manipulation technique (Figure 4) as described by Newell.¹⁷ Immediately following manipulation, passive non-weight-bearing midtarsal pronation was full with a 0/10 NPRS score. Moreover, 20 repetitions of active mid-tarsal pronation in weight bearing was pain free. A novel exercise emphasizing the entire kinetic chain for lengthening the posterior tibialis was implemented (Figure 5). This exercise is performed in the standing position with the combined movements of active mid-tarsal pronation, rear foot eversion, tibial internal rotation and knee extension. This lengthening exercise for the posterior tibialis was added to the patient's home exercise program. Immediately post treatment the patient was able to run 400 yards with a 0/10 NPRS score. Elastic taping

techniques were not used this session as the patient demonstrated significant functional pain relief after joint manipulation.

During follow up visit number eight the patient reported voluntarily increasing her running distances resulting in an exacerbation of symptoms to a 6/10 on the NPRS. Soft tissue mobilization and manual stretching were performed for the posterior tibialis and gastrocnemius as described earlier. Upon re-assessment the cuboid internal rotation mobility remained symmetrical as well as passive midtarsal pronation. The patient continued active pain free weight-bearing muscular re-education movement exercises (Figure 5) to encourage midtarsal pronation in addition to previously assigned exercises as part of the home program. Although the patient had a reduction in symptoms and reports of pain during ambulation and activities with and without the use of elastic tape, she requested continued use of taping techniques. However, to minimize unnecessary treatments, the patient was educated on the likely placebo effect of interventions and agreed to discontinue elastic taping techniques and focus efforts on



Figure 4. Cuboid whip manipulation performed with the patient in prone and the operator utilizing both hands to deliver a high velocity low amplitude internal rotation force through the cuboid-calcaneus joint



Figure 5. Weight bearing pronation exercise while actively assuming knee extension and lower leg internal rotation in the standing position creates pronation of the rear and mid-foot to lengthen the posterior tibialis in a weight bearing position

Table 2. Home Exercise Program Progression

Exercise	Early Phase (Week 1-6)	Middle Phase (Week 7-16)	Late Phase (Week 17-19)
Single leg stance with clock kicks	15 sec x 3 rep	20 sec x 3 rep	20 sec x 4 rep
Heel raises with ball squeeze	2 sets x 10 rep	3 sets x 10 rep	3 sets x 15 rep
Weight bearing mid-tarsal supination/pronation	2 sets x 20 rep	2 sets x 30 rep	2 sets x 40 rep
Double heel raise up with single lowering	Not performed	15 rep	2 sets x 15 rep
Abbreviations: Seconds (sec) Repetitions (rep)			

the home exercise program. Strength improvements are reported in Table 1. LEFS improved to a 65/80.

During visit number nine the patient presented with only slight 1/10 discomfort at rest and with ambulation on the NPRS at the medial navicular. Remaining limitations included limited arch ratio without pain, inability to perform more than four single heel raises and 2/10 pain during running. Soft tissue mobilization, the cuboid whip, posterior tibialis stretching and the home exercise program were continued for three visits in order to maintain mobility. Pain and tenderness to palpation along the lower leg and medial malleoli was resolved. LEFS revealed a score of 69/80.

OUTCOME

The patient was seen for 12 visits over 28 weeks. During the final session the patient reported a 0/10 NPRS score at rest, with ambulation and while running 13.1 miles. Push off during gait was pain free along with a normalized arch ratio and 10 single leg heel raises. The LEFS score decreased to 78/80 resulting in an overall improvement of 15 points. The patient exceeded the nine point reported minimal detectable change for the LEFS as determined in prior studies.¹⁸

DISCUSSION

This case report highlights several important aspects of clinical reasoning contributing to the successful outcomes for this patient. Although examination of this patient's symptoms suggested a diagnosis of pre-Stage I PTTD, an uncommon impairment of limitations in cuboid joint mobility may have contributed to this patient's PTTD. Re-assessment of impair-

ments during the course of treatment was crucial in achieving successful outcomes. The importance of monitoring functional progress and re-evaluating impairments to achieve the goal of full pain free patient activity was described.

This patient demonstrated signs and symptoms consistent with pre-Stage I chronic posterior tibialis tendon dysfunction. Posterior tibialis tendon dysfunction is often accompanied by increased mid-tarsal pronation which causes a lengthening of the posterior tibialis with weight-bearing activities leading to irritation and pain.^{3,5} Prior investigations have reported optimal outcomes with the combination of orthoses wear and exercise to diminish the midtarsal overpronation.⁴ However, the uncommon finding in this case report was a lack of midtarsal pronation due to a limitation of cuboid internal rotation.⁸ It is important that clinicians assess joint mobility because clinically it is more common for a midtarsal hypermobility to be present.¹⁹ During weight-bearing activities, this patient was unable to functionally utilize midtarsal pronation due to a lack of cuboid internal rotation joint mobility. The authors theorized that the limitation of this joint mobility resulted in the inability for the posterior tibialis to function effectively and hence PTTD "pre-Stage I" condition ensued.

Although the patient was appropriately treated for PTTD "pre-Stage I" for the first five visits, functional gains were minimal. The reflective practice of the physical therapist in recognizing minimal gains after six weeks and re-assessing impairments after the fifth visit was instrumental in identifying an additional treatment approach. The use of clinical reasoning skills is based on two guiding principles

proposed in this case report. These are: (1) mobility is needed for full function of the muscle and (2) full length is needed of the muscle to gain functional strength. The presence of the long-standing painful dysfunction was likely perpetuated as the muscle/tendon was unable to function normally due to a lack of mobility at the midtarsal joint. Once midtarsal pronation mobility was restored, strength deficits were addressed and full function could be achieved.

Although soft tissue mobilization, stretching and taping techniques provided some pain relief during the course of treatment, cuboid manipulation was the most significant treatment factor resulting in the greatest level of immediate pain reduction and improved ability to run. The dramatic improvement in pain free running following a cuboid manipulation could be related to several mechanisms. The traditional mechanism lends merit to the hypothesis that the cuboid mobility impairment is restored after the manipulation resulting in improved mechanics for the posterior tibialis. Another mechanism could be that a reverse neurological sensitization occurs post cuboid manipulation as a result of neurophysiological effects.²⁰

This case report also provides evidence of the value of the physical therapist's individualized home exercise program and long-term supervision. The physical therapist selectively chose supportive home exercises with rigid activity parameters. The exercise of lengthening the posterior tibialis while standing provided a stretching intervention to the impaired muscle tissue while simultaneously facilitating the mid-foot pronation movement. The theory supporting this weight bearing exercise is that muscle lengthening can occur in a manner specific to the posterior tibialis function. Moreover, when the patient was prescribed these movement re-education exercises very strict activity limitations were imposed for running. Patient independence with management of this chronic condition was emphasized. During the six-week break, the patient remained in communication with the physical therapist regarding home exercises and running parameters to ensure progress was maintained. While a six week break in a traditional physical therapist plan of care is uncommon, this case report demonstrates the value in consistent physical therapist/ patient

communication and independent patient management through a well-defined home exercise program to decrease symptoms in patients who experience pain or limitation from chronic conditions.

Several limitations to this case report exist. Utilizing the LEFS may not have been the most specific self-report measure for this patient. A region specific outcome measure such as the foot function index could be more sensitive to change in individuals experiencing medial ankle and foot pain.²¹ Another limitation is the lack of a valid and reliable test for cuboid mobility assessment.¹⁶ While mobility of the cuboid is commonly assessed in clinical practice further research is needed to establish the diagnostic accuracy of this examination test.

CONCLUSION

In conclusion, standard physical therapist practice should include reflective decision-making and alterations of intervention selection when outcomes are not favorable. This case report identifies the importance of looking beyond common factors contributing to a dysfunction as well as the significance of re-evaluation of impairments when functional gain is minimal. By following these aspects of clinical reasoning, this patient was able to progress from an inability to run without pain to running over 13 miles pain free.

REFERENCES

1. Geideman WM, Johnson JE. Posterior tibial tendon dysfunction. *J Orthop Sports Phys Ther.* 2000;30(2):68-77.
2. Durrant B, Chockalingam N, Hashmi F. Posterior tibial tendon dysfunction: a review. *J Am Podiatr Med Assoc.* 2011;101(2):176-186.
3. Patla CE, Abbott JH. Tibialis posterior myofascial tightness as a source of heel pain: diagnosis and treatment. *J Orthop Sports Phys Ther.* 2000;30(10):624-632.
4. Kulig K, Reischl SF, Pomrantz AB, Burnfield JM, Mais-Requejo S, Thordarson DB, Smith RW. Nonsurgical management of posterior tibial tendon dysfunction with orthoses and resistive exercise: a randomized controlled trial. *Phys Ther.* 2009;89(1):26-37.
5. Johnson KA, Strom DE. Tibialis posterior tendon dysfunction. *Clin Orthop Relat Res.* 1989(239):196-206.
6. Dananberg HJ. Manipulation of the ankle as a method of treatment for ankle and foot pain. *J Am Podiatr Med Assoc.* 2004;94(4):395-399.

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7. Jennings J, Davies GJ. Treatment of cuboid syndrome secondary to lateral ankle sprains: a case series. *J Orthop Sports Phys Ther.* 2005;35(7):409-415.
 8. Brandon K, Patla C. Differential diagnosis and treatment of iliotibial band pain secondary to a hypomobile cuboid in a 24-year-old female triathlete. *J Man Manip Ther.* 2013;21(3):142-147.
 9. Cleland JA, Abbott JH, Kidd MO, Stockwell S, Cheney S, Gerrard DF, Flynn TW. Manual physical therapy and exercise versus electrophysical agents and exercise in the management of plantar heel pain: a multicenter randomized clinical trial. *J Orthop Sports Phys Ther.* 2009;39(8):573-585.
 10. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for assessment of pain intensity in adults: a systematic literature review. *J Pain Symptom Manag.* 2011;41(6):1073-1093.
 11. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. *Phys Ther.* 1999;79(4):371-383.
 12. Lin CW, Moseley AM, Refshauge KM, Bundy AC. The lower extremity functional scale has good clinimetric properties in people with ankle fracture. *Phys Ther.* 2009;89(6):580-588.
 13. Norkin CC, White DJ. *Measurement of joint motion: a guide to goniometry*: FA Davis; 2009.
 14. Hegedus EJ, Cook C, Fiander C, Wright A. Measures of arch height and their relationship to pain and dysfunction in people with lower limb impairments. *Physiother Res International.* 2010;15(3):160-166.
 15. Kendall FP ME, Provance P, Rodgers M, Romanill W. *Muscles: Testing and Function with Posture and Pain.* 5th ed. Hagerstown, MD: Lippincott Williams and Wilkins; 2005.
 16. Durall CJ. Examination and treatment of cuboid syndrome: a literature review. *Sports Health.* 2011;3(6):514-519.
 17. Newell SG WA. Cuboid syndrome. *Phys Sports Med.* 1981;9(4):71-76.
 18. Shultz S, Olszewski A, Ramsey O, Schmitz M, Wyatt V, Cook C. A systematic review of outcome tools used to measure lower leg conditions. *Int J Sports Phys Ther.* 2013;8(6):838-848.
 19. Remvig L, Jensen DV, Ward RC. Epidemiology of general joint hypermobility and basis for the proposed criteria for benign joint hypermobility syndrome: review of the literature. *J Rheumatol.* 2007;34(4):804-809.
 20. Matthews ML, Claus AP. Two examples of 'cuboid syndrome' with active bone pathology: why did manual therapy help? *Man Ther.* 2014;19(5):494-498.
 21. Budiman-Mak E, Conrad KJ, Roach KE. The Foot Function Index: a measure of foot pain and disability. *J Clin Epidemiol.* 1991;44(6):561-570.